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Poster Presentation Abstracts

Session: Biomaterials and Implants — Bone Substitutes

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TAILORING THE DEGRADATION AND BIOLOGICAL RESPONSE OF A MAGNESIUM—STRONTIUM ALLOY FOR POTENTIAL BONE SUBSTITUTE APPLICATION

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Introduction: Bone defects are very challenging in orthopedic practice. There are many practical and clinical shortcomings in the repair of the defect by using autografts, allografts or xenografts, which continue to motivate the search for better alternatives. The ideal bone grafts should provide mechanical support, fill osseous voids and enhance the bone healing. Biodegradable magnesium-strontium (Mg-Sr) alloys demonstrate good biocompatibility and osteoconductive properties, which are promising biomaterials for bone substitutes. The aim of this study was to evaluate and pair the degradation of Mg-Sr alloys for grafting with their clinical demands.
Materials and Methods: Mg-Sr alloys with the actual composition of 1.5 wt.% Sr (confirmed by ICP) was prepared by melting down pure Mg (99.9 wt.%) and pure Sr (99.99 wt.%) in a high purity graphite crucible. A pulsed bipolar electrical source (WHD-20) with power of 2 kW was used to prepare the micro-arc oxidation (MAO) coatings. The microstructure and phase constitution of Mg-Sr alloy and coating were investigated by optical microscopy, XRD, SEM and EDS. The in vitro degradation and biological properties including in vitro cytocompatibility and in vivo implantation were studied.
Results and Discussion: The results showed that the as-cast Mg-Sr alloy exhibited a rapid degradation rate compared with the as-extruded alloy due to the intergranular distribution of second phase and micro-galvanic corrosion. However, the initial degradation could be tailored by the coating protection, which was proved to be cytocompatible and also suitable for bone repair observed by *in vivo* implantation. The integrated fracture calluses were formed and bridged the fracture gap without gas bubble accumulation, meanwhile the substitutes simultaneously degraded.
Conclusions: The results showed the as-cast Mg-Sr alloy exhibited a rapid degradation rate compared with the as-extruded alloy due to the intergranular distribution of second phase and micro-galvanic corrosion. Comparatively, the MAO coating can regulate the degradation, which exhibits initially slow corrosion and then faster at the latter stage. It is beneficial for the implants without any signs of cytotoxicity and harmful effects on osteoblasts proliferation. The in vivo implantation test found that the integrated fracture calluses were formed and bridged the fracture gap without gas bubble accumulation for the as-cast Mg-Sr alloy with coating, meanwhile the substitutes simultaneously degraded after 8 weeks. In conclusion, the as-cast Mg-Sr alloy with coating is potential to be used for bone substitute alternative.
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Session: Biomaterials and Implants

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Zn-BASED BIODEGRADABLE ALLOYS IN ORTHOPAEDICS

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Introduction: Biodegradable metals have attracted considerable attentions in recent years. Besides the early launched biodegradable Mg [1—3] and Fe [4—6] metals, Zn, an essential element with osteogenic potential of human body, is regarded and studied as a new kind of potential biodegradable metal quite recently [7,8]. Unfortunately, pure Zn is soft, brittle and has low mechanical strength in the practice, which needs further improvement in order to meet the clinical requirements. On the other hand, the widely used industrial Zn-based alloys usually contain biotoxic elements (for instance, ZA series contain toxic Al elements up to 40 wt.%), which subsequently bring up biosafety concerns.
Materials & Methods: In the present work, novel Zn-1X binary alloys, with the addition of nutrition elements Mg, Ca and Sr were designed (cast, rolled and extruded Zn-1Mg, Zn-1Ca and Zn-1Sr). Their microstructure and mechanical property, degradation and *in vitro* and *in vivo* biocompatibility were studied systematically.
Results & Discussion: The results demonstrated that the Zn-1X (Mg, Ca and Sr) alloys have profoundly modified the mechanical properties and biocompatibility of pure Zn. Adding the alloying elements Mg, Ca and Sr, the YS, UTS and elongation of Zn-1X binary alloys are significantly improved. The hemolysis rates of Zn-1X alloys are quite low (the addition of alloying elements into Zn can reduce its adhesive platelets number, indicate their excellent in vivo anti-platelets adhesion property and antithrombotic properties). Adding the alloying elements Mg, Ca and Sr into Zn can significantly increase the viability of MG63 and can promote the MG63 cell proliferation compared with the pure Zn and negative control groups. After a short period (after 1 week), the periosteal reaction and reactive hyperplasia of bone were observed around the cortical bone of distal femur in Zn-1X pins groups and showed the circumferential osteogenesis, thus the cortical bone around the pins became thicker than that in the sham control group, indicating that the Zn-1X pins could promote new bone formation when compared to that in the sham control group.
Conclusions: In summary, we developed Zn-X binary alloys for use as biodegradable materials within bone. It has been demonstrated that the Zn-1X alloys have greatly enhanced the mechanical properties, corrosion behavior and biocompatibility of pure Zn by adding the alloying elements of Mg, Ca and Sr. Zn-1X alloys showed great potential for use in a new generation of biodegradable implants, opening up a new avenue in the area of biodegradable metals.
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